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Technical Literature for

# TFT-LCD module

MODEL No. LD600D3LH1

CUSTOMER'S APPROVAL

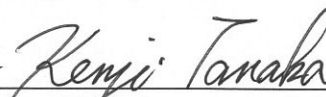
DATE \_\_\_\_\_

BY \_\_\_\_\_

PRESENTED

Engineering Department

BY



Date 2013. 2. 4

## RECORDS OF REVISION

MODEL NO. LD600D3LH1

[illegible]

## 1. Application

This specification applies to the color 60.0" TFT-LCD module LD600D3LH1.

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## 2. Overview

This module is a color active matrix LCD module incorporating amorphous silicon TFT (Thin Film Transistor). It is composed of a color TFT-LCD panel, driver ICs, control circuit and LED back light system etc. Graphics and texts can be displayed on a 1920×RGB×1080 dots panel with about 16.7 million colors by using 10 bit LVDS (Low Voltage Differential Signaling) to interface and +12V of DC supply voltages.

And in order to improve the response time of LCD, this LCD module applies the Over Shoot driving (O/S driving) technology for the control circuit. In the O/S driving technology, signals are being applied to the Liquid Crystal according to a pre-fixed process as an image signal of the present frame when a difference is found between image signal of the previous frame and that of the current frame after comparing them.

With this technology, image signals can be set so that liquid crystal response completes within one frame. As a result, motion blur reduces and clearer display performance can be realized.

### 3. Model outline

| Parameter                    | Specifications                            | Unit              |
|------------------------------|---|-------------------|
| Display size                 | 152.496(Diagonal)                         | cm                |
|                              | 60.0379 (Diagonal)                        | inch              |
| Active area                  | 1329.12 (H) × 747. (V)                    | mm                |
| Pixel format                 | 1920 (H)×1080 (V)<br>(1 pixel=R+G+B dots) | pixel             |
| Pixel pitch                  | 0.6925 (H)×0.6925 (V)                     | mm                |
| Pixel configuration          | R, G, B vertical stripe                   |                   |
| Display mode                 | Normally black                            |                   |
| Back light                   | LED Direct<br>With Local dimming function |                   |
| Brightness                   | 2,000                                     | cd/m <sup>2</sup> |
| Contrast ratio               | Typ. 5,000 : 1<Local dimming OFF>         |                   |
| Unit outline dimensions (*1) | 1367.5 (W)×783.6 (H)×(109.3 (D))          | mm                |
| Weight                       | (27.6±2.0)                                | kg                |
| Surface treatment            | LR coating<br>Hard coating: 2H and more   |                   |

(\*1)Outline dimensions are shown in Fig.1

## 4. Input Terminals

### 4.1. TFT-LCD panel driving

CN6 [LED CONTROL PWB] (Interface signals)

Using connectors : FX16S-41S-0.5SH (HIROSE)

Mating connectors : FX16M1-41P-HC (HIROSE)

| Pin No. | Symbol       | Function                                 | Remark          |
|---------|--------------|--|-----------------|
| 1       | GND          | GND                                      |                 |
| 2       | AIN0-        | Aport(-)LVDS CH0 differential data input |                 |
| 3       | AIN0+        | Aport(+)LVDS CH0 differential data input |                 |
| 4       | AIN1-        | Aport(-)LVDS CH1 differential data input |                 |
| 5       | AIN1+        | Aport(+)LVDS CH1 differential data input |                 |
| 6       | AIN2-        | Aport(-)LVDS CH2 differential data input |                 |
| 7       | AIN2+        | Aport(+)LVDS CH2 differential data input |                 |
| 8       | GND          | GND                                      |                 |
| 9       | ACK-         | Aport(-)LVDS differential Clock signal   |                 |
| 10      | ACK+         | Aport(+)LVDS differential Clock signal   |                 |
| 11      | AIN3-        | Aport(-)LVDS CH3 differential data input |                 |
| 12      | AIN3+        | Aport(+)LVDS CH3 differential data input |                 |
| 13      | AIN4-        | Aport(-)LVDS CH4 differential data input |                 |
| 14      | AIN4+        | Aport(+)LVDS CH4 differential data input |                 |
| 15      | GND          | GND                                      |                 |
| 16      | BIN0-        | Bport(-)LVDS CH0 differential data input |                 |
| 17      | BIN0+        | Bport(+)LVDS CH0 differential data input |                 |
| 18      | BIN1-        | Bport(-)LVDS CH1 differential data input |                 |
| 19      | BIN1+        | Bport(+)LVDS CH1 differential data input |                 |
| 20      | BIN2-        | Bport(-)LVDS CH2 differential data input |                 |
| 21      | BIN2+        | Bport(+)LVDS CH2 differential data input |                 |
| 22      | GND          | GND                                      |                 |
| 23      | BCK-         | Bport(-)LVDS differential Clock signal   |                 |
| 24      | BCK+         | Bport(+)LVDS differential Clock signal   |                 |
| 25      | BIN3-        | Bport(-)LVDS CH3 differential data input |                 |
| 26      | BIN3+        | Bport(+)LVDS CH3 differential data input |                 |
| 27      | BIN4-        | Bport(-)LVDS CH4 differential data input |                 |
| 28      | BIN4+        | Bport(+)LVDS CH4 differential data input |                 |
| 29      | GND          | GND                                      |                 |
| 30      | APL_OUTSCALE | Brightness Control                       | [NOTE2],[NOTE3] |
| 31      | Reserved     | -  | Must be OPEN    |
| 32      | Reserved     | -  | Must be OPEN    |
| 33      | Reserved     | -  | Must be OPEN    |
| 34      | APL_OFFSET   | Local Dimming Effect Control             | [NOTE2],[NOTE3] |
| 35      | Reserved     | -  | Must be OPEN    |
| 36      | Reserved     | -  | Must be OPEN    |
| 37      | Reserved     | -  | Must be OPEN    |

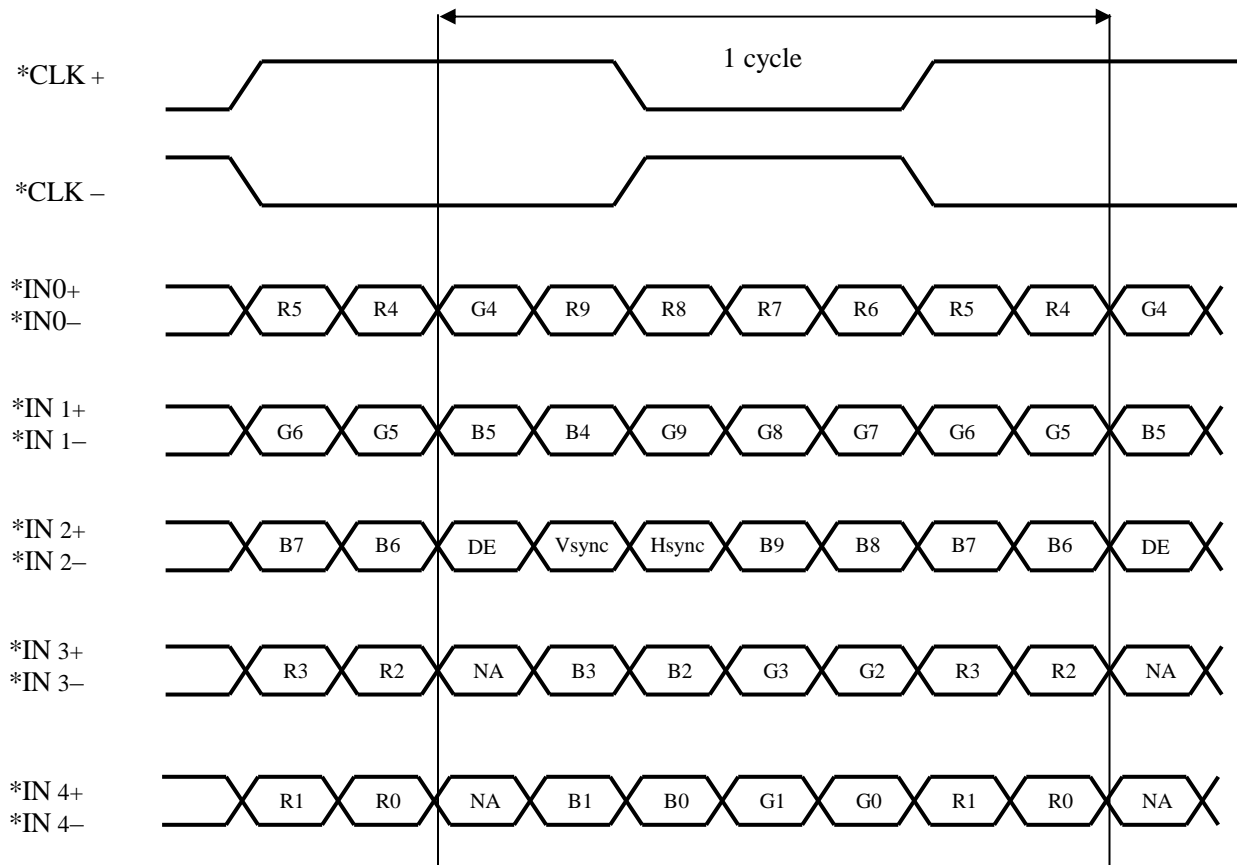
|    |          |   |              |
|----|----------|---|--------------|
| 38 | Reserved | - | Must be OPEN |
| 39 | Reserved | - | Must be OPEN |
| 40 | Reserved | - | Must be OPEN |
| 41 | Reserved | - | Must be OPEN |

[NOTE 1] LVDS Data order

| Data |         |
|------|---------|
| TA0  | R4      |
| TA1  | R5      |
| TA2  | R6      |
| TA3  | R7      |
| TA4  | R8      |
| TA5  | R9(MSB) |
| TA6  | G4      |
| TB0  | G5      |
| TB1  | G6      |
| TB2  | G7      |
| TB3  | G8      |
| TB4  | G9(MSB) |
| TB5  | B4      |
| TB6  | B5      |
| TC0  | B6      |
| TC1  | B7      |
| TC2  | B8      |
| TC3  | B9(MSB) |
| TC4  | Hsync   |
| TC5  | Vsync   |
| TC6  | DE(*)   |
| TD0  | R2      |
| TD1  | R3      |
| TD2  | G2      |
| TD3  | G3      |
| TD4  | B2      |
| TD5  | B3      |
| TD6  | NA      |
| TE0  | R0      |
| TE1  | R1      |
| TE2  | G0      |
| TE3  | G1      |
| TE4  | B0      |
| TE5  | B1      |
| TE6  | NA      |

NA: Not Available

(\*)Since the display position is prescribed by the rise of DE (Display Enable) signal, please do not fix DE signal during operation at "High".

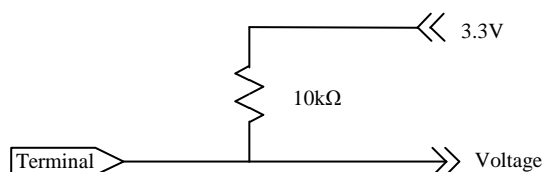


DE: Display Enable, NA: Not Available (Fixed Low)

[NOTE 2] Brightness and Local Dimming Effect Control (Pulse Dimming)

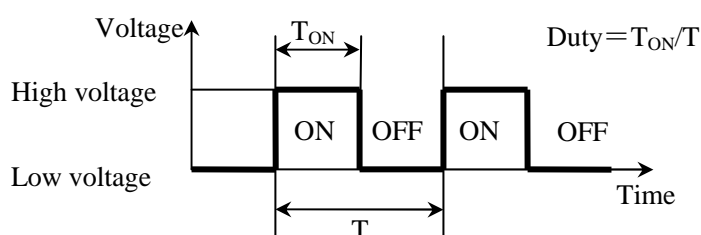
Pin No.30 & 34 are Open Drain control. (They are pulled up internally.)

|     | MIN | TYP | MAX  |
|-----|-----|-----|------|
| OFF | -   | -   | 0.6V |



Pin No.30 & 34 are used for the control of the PWM duty with input pulse (450Hz).

Input PWM waveform



|                             |      | MIN. | TYP | MAX.  | Remark  |
|-----------------------------|------|------|-----|-------|---|
| Pulse signal                | [Hz] | 445  | 450 | 455   |   |
| Brightness (Duty)           | [%]  | 5.0  | <-> | 100.0 | Ta=25°C<br>Pulse signal=(450) Hz<br>100%=Maximum Brightness |
| Local Dimming Effect (Duty) | [%]  | 5.0  | <-> | 100.0 | Ta=25°C<br>Pulse signal=(450) Hz<br>100%=No effect          |
| Low voltage                 | V    | -    | 0   | 0.6   |   |
| High voltage                | V    | 3.0  | 3.3 | 3.6   |   |

[Note]

- Limit of jitter of frequency: Max.  $\pm 0.3\%$
- If the jitter is over the range above, the screen may flicker.

[NOTE 3] Limitation of Brightness and Local Dimming Effect

- Available value: 96steps for 5.0% to 100.0%. (Ex. 10.0% or 77.0%)  
: MAX.  $\pm 0.05\%$

- If the value does not meet the condition above (Ex. 10.3% or 77.6%), the screen may flicker.
- When the product of Brightness and Local Dimming Effect is less than 5.0%, the screen may blackout.
- In case of the product above is less than 5.0%, please limit the Local Dimming Effect as follows.

$$-LocalDimmingEffect[\%] \geq 100 \times \frac{5.0}{Brightness[\%]}$$

(Setting example)

| Brightness | Local Dimming Effect |                  |
|------------|----------------------|------------------|
|            | MIN. (Strong Effect) | MAX. (No Effect) |
| 100%       | 5%                   | 100%             |
| 50%        | 10%                  | 100%             |
| 10%        | 50%                  | 100%             |

## CN5 [LED CONTROL PWB] (+12V DC power supply)

Using connectors : SM07B-PASS-TBT (JST)

Mating connectors : PAP-07V-S (JST)

| Pin No. | Symbol | Function          | Remark       |
|---------|--------|-------------------|--------------|
| 1       | VCC    | +12V Power Supply |              |
| 2       | VCC    | +12V Power Supply |              |
| 3       | -      | -                 | Must be OPEN |
| 4       | -      | -                 | Must be OPEN |
| 5       | -      | -                 | Must be OPEN |
| 6       | GND    | GND               |              |
| 7       | GND    | GND               |              |

## CN7 [LED CONTROL PWB] (Control Signals)

Using connectors : S18B-PUDSS-1 (JST)

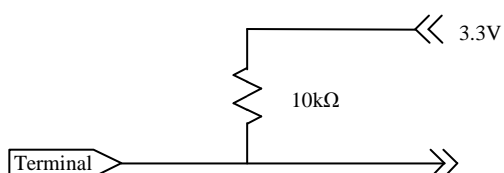
Mating connectors : PUDP-18V-S (JST)

| Pin No. | Symbol   | Function                     | Remark         |
|---------|----------|------------------------------|----------------|
| 1       | GND      | GND                          |                |
| 2       | -        | -                            | Must be OPEN   |
| 3       | -        | -                            | Must be OPEN   |
| 4       | nLCD_ON  | LCD ON/OFF control           | [NOTE2]        |
| 5       | -        | -                            | Must be OPEN   |
| 6       | -        | -                            | Must be OPEN   |
| 7       | GND      | GND                          |                |
| 8       | -        | -                            | Must be OPEN   |
| 9       | -        | -                            | Must be OPEN   |
| 10      | GND      | GND                          |                |
| 11      | TEST     | Connect to GND               | Connect to GND |
| 12      | nLED_ON  | LED ON/OFF control           | [NOTE1]        |
| 13      | nRDY     | Control Status               | [NOTE3]        |
| 14      | nLED_ERR | LED Error                    | [NOTE4]        |
| 15      | -        | -                            | Must be OPEN   |
| 16      | -        | -                            | Must be OPEN   |
| 17      | nMODE    | Local Dimming ON/OFF control | [NOTE1]        |
| 18      | GND      | GND                          | Must be OPEN   |

## [NOTE 1] ON/OFF

|    | MIN | TYP | MAX  |
|----|-----|-----|------|
| ON | -   | -   | 0.6V |

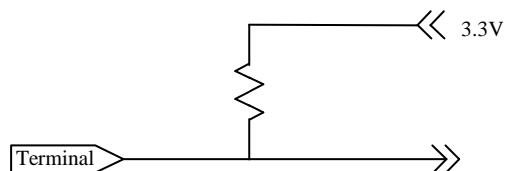
These ports are Open Drain control.



## [NOTE 2] ON/OFF

|    | MIN | TYP | MAX   |
|----|-----|-----|-------|
| ON | -   | -   | 0.45V |

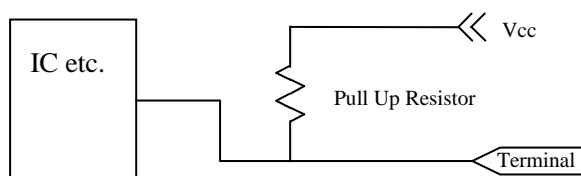
This port is Open Drain control.



## [NOTE 3] Ready Detection

|       | MIN        | TYP | MAX  |
|-------|------------|-----|------|
| Busy  | Open Drain |     |      |
| Ready | -          | -   | 0.4V |

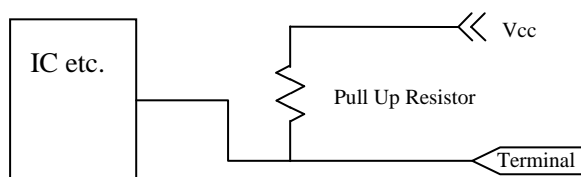
Please use the terminal as follows. (Pull-up)



## [NOTE 4] LED Error Detection

|          | MIN        | TYP | MAX  |
|----------|------------|-----|------|
| Error    | -          | -   | 0.4V |
| No Error | Open Drain |     |      |

If the state of nLED\_ERR is error, please restart (turn off and then turn on) the module.  
Please use the terminal as follows. (Pull-up)



## CN5 [LED DRIVER PWB] (LED Power supply)

Using connectors : B6P-VH-B (JST)

Mating connectors : VHR-6N (JST)

| Pin No. | Symbol | Function          | Remark |
|---------|--------|-------------------|--------|
| 1       | 24V1   | +24V Power Supply |        |
| 2       | 24V2   | +24V Power Supply |        |
| 3       | 24V3   | +24V Power Supply |        |
| 4       | GND    | GND               |        |
| 5       | GND    | GND               |        |
| 6       | GND    | GND               |        |

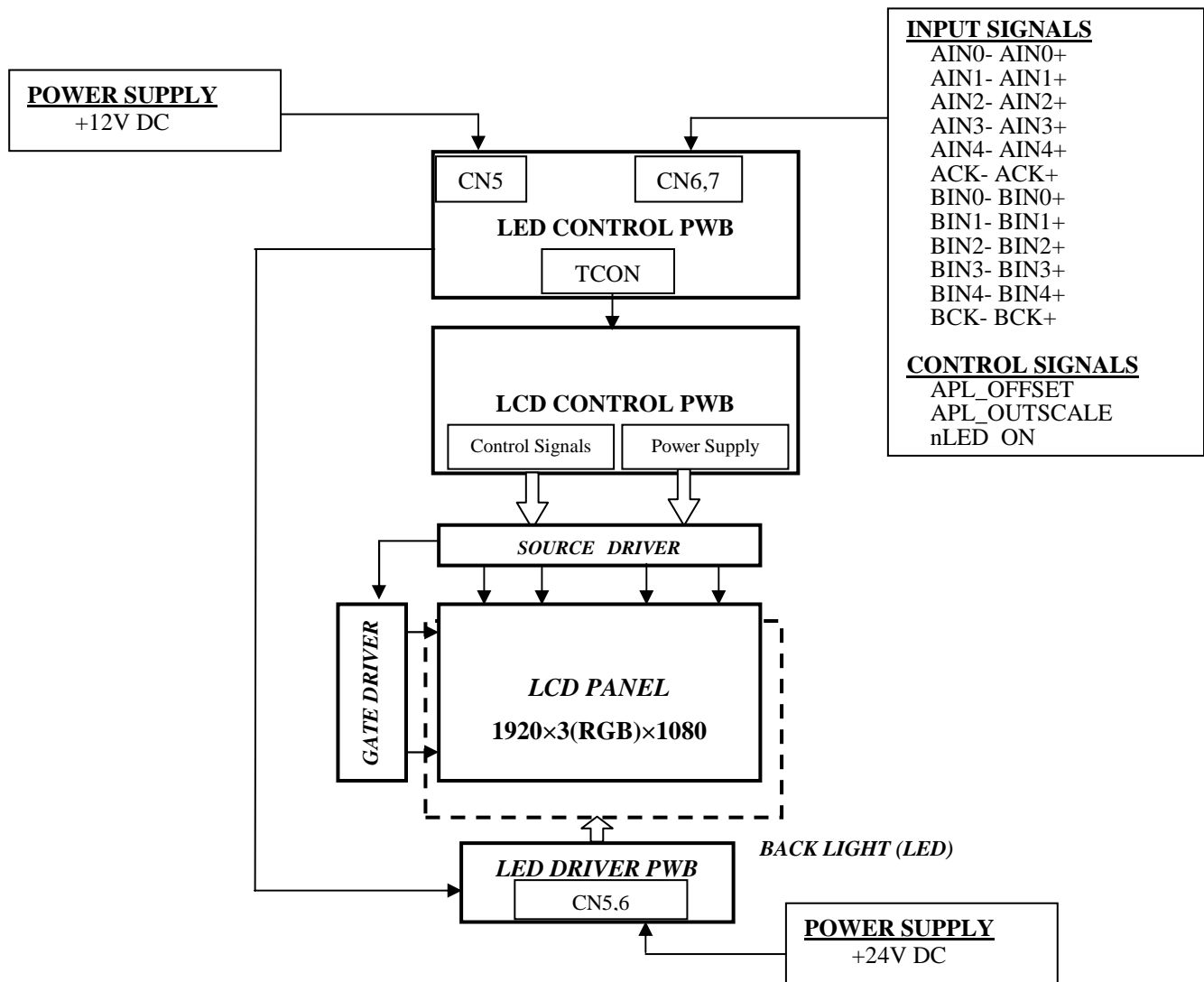
## CN6 [LED DRIVER PWB] (LED Power supply)

Using connectors : B7P-VH-B (JST)

Mating connectors : VHR-7N (JST)

| Pin No. | Symbol | Function          | Remark |
|---------|--------|-------------------|--------|
| 1       | 24V4   | +24V Power Supply |        |
| 2       | 24V5   | +24V Power Supply |        |
| 3       | 24V6   | +24V Power Supply |        |
| 4       | NC     | NC                |        |
| 5       | GND    | GND               |        |
| 6       | GND    | GND               |        |
| 7       | GND    | GND               |        |

## 4.2. Interface block diagram



## 4.3. The back light system characteristics

The back light system is direct type with 1152 LEDs.

The characteristics of the LED are shown in the following table.

| Item      | Symbol | Min. | Typ.    | Max. | Unit | Remarks |
|-----------|--------|------|---------|------|------|---------|
| Life time | $T_L$  | —    | (37000) | —    | Hour | [NOTE]  |

[NOTE]

- LED life time is defined as the time when brightness become 70% of the original value in the continuous Operation under the condition of  $T_a=25^{\circ}\text{C}$

## 5. Absolute Maximum Rating

| Parameter                           | Symbol           | Condition                | Ratings             | Unit               | Remark           |
|-------------------------------------|------------------|--------------------------|---------------------|--------------------|------------------|
| Input Voltage<br>(for Control)      | $V_I$            | $T_a=25^{\circ}\text{C}$ | -0.3 ~ 3.6<br>(TBD) | V                  | [NOTE1]          |
| 12V supply voltage<br>(for Control) | VCC              | $T_a=25^{\circ}\text{C}$ | 0 ~ 14<br>(TBD)     | V                  |                  |
| Storage temperature                 | $T_{\text{stg}}$ |                          | -25 ~ 60            | $^{\circ}\text{C}$ |                  |
| Operation temperature<br>(Ambient)  | $T_{\text{opa}}$ |                          | 0 ~ 50              | $^{\circ}\text{C}$ | [NOTE2]          |
| LED terminal<br>temperature         | $T_c$            |                          | 0 ~ 80              | $^{\circ}\text{C}$ | [NOTE3], [NOTE4] |
| LCD surface<br>temperature          | $T_{\text{sf}}c$ |                          | 0 ~ 60              | $^{\circ}\text{C}$ | [NOTE4]          |

[NOTE1] APL\_OFFSET, APL\_OUTSCALE, nLCD\_ON, nLED\_ON, nMODE: Open Drain Inputs

[NOTE2] Humidity 95% RH Max ( $T_a$   $^{\circ}\text{C}$  40 $^{\circ}\text{C}$ )

Maximum wet-bulb temperature should be less than 40 $^{\circ}\text{C}$ . ( $T_a > 40^{\circ}\text{C}$ )

No condensation.

[NOTE3] LED terminal temperature should be measured on the LED PWBs.

[NOTE4]  $T_c$  and  $T_{\text{sf}}c$  in operation must be in the above range on any condition.

## 6. Electrical Characteristics

### 6.1 Control Circuit driving

| Parameter                                       |                     | Symbol           | Min. | Typ. | Max   | Unit | Remark                        |
|---|---------------------|------------------|------|------|-------|------|-------------------------------|
| +12V supply voltage                             | Supply voltage      | VCC              | 11.4 | 12.0 | 12.6  | V    |                               |
|   | Current dissipation | ICC              |      | 2.0  | 3.5   | A    | [NOTE 6]<br>Irush 5.5A        |
| Permissible input ripple voltage                |                     | V <sub>RP</sub>  | —    | —    | —     | mV   |                               |
| Differential input threshold voltage            | High                | V <sub>TH</sub>  |      | —    | +100  | mV   | [NOTE 1],<br>[NOTE 5]         |
|   | Low                 | V <sub>TL</sub>  | -100 | —    |       | mV   |                               |
| Common mode Voltage (@ V <sub>id</sub>  =100mV) |                     | V <sub>CM</sub>  | 0.2  | 1.2  | 2.0   | V    |                               |
| Differential input voltage                      |                     | V <sub>id</sub>  | 100  |      | 600   | mV   |                               |
| Differential input leak current                 |                     | I <sub>Iz</sub>  | 10   | —    | 10    | μA   |                               |
| Input Low voltage1                              |                     | V <sub>IL1</sub> | -    | -    | 0.6   | V    | [NOTE 2]                      |
| Input High voltage1                             |                     | V <sub>IH1</sub> | -    | -    | -     | V    |                               |
| Input Low voltage2                              |                     | V <sub>IL2</sub> | -    | -    | 0.45  | V    | [NOTE 3]                      |
| Input High voltage2                             |                     | V <sub>IH2</sub> | -    | -    | -     | V    |                               |
| Output Low voltage                              |                     | V <sub>OL</sub>  | —    | —    | 0.4   | V    | [NOTE 4]                      |
| Output High voltage                             |                     | V <sub>OH</sub>  | —    | —    | —     | V    |                               |
| Input leak current1                             |                     | I <sub>IL1</sub> | —    | —    | (TBD) | μA   | V <sub>I</sub> =0V<br>[NOTE2] |
| Input leak current2                             |                     | I <sub>IL2</sub> | —    | —    | (TBD) | mA   | V <sub>I</sub> =0V<br>[NOTE3] |
| Terminal resistor                               |                     | R <sub>T</sub>   | —    | 100  | —     | Ω    |                               |

[NOTE 1] \*CK±, \*IN0±, \*IN1±, \*IN2±, \*IN3±, \*IN4± @ V<sub>CM</sub>=1.2V

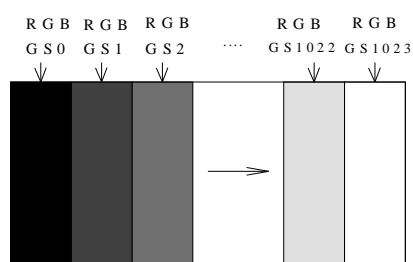
[NOTE 2] APL\_OFFSET, APL\_OUTSCALE, nLED\_ON, nMODE, TEST: Open Drain Inputs

[NOTE 3] nLCD\_ON: Open Drain Inputs

[NOTE 4] nLED\_ERR, nRDY: OpenDrain Output

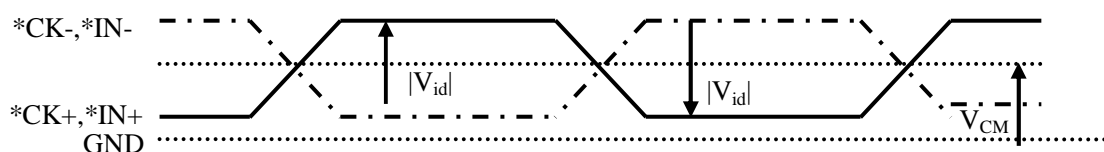
[NOTE 5] V<sub>CM</sub>: Common mode voltage of LVDS driver.

[NOTE 6] Typical current situation: 1024 gray-bar patterns. (VCC = +12.0V)



VCC = +12.0V

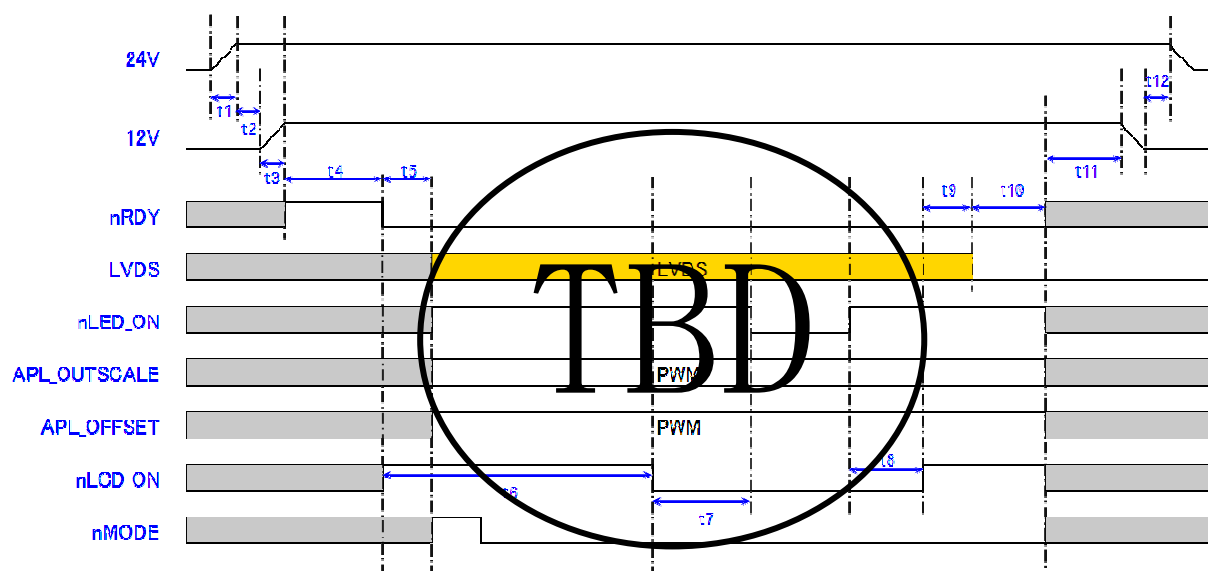
Clock = 145.8MHz



## 6.2 LED Circuit driving

| Parameter     | Symbol  | Min.   | Typ.   | Max  | Unit | Remark |
|---------------|---------|--------|--------|------|------|--------|
| Input voltage | LED VCC | (22.8) | 24.0   | 25.2 | V    |        |
| Input current | LED ICC |        | (16.5) | 23   | A    |        |

## 6.3 Sequence(TBD)



## Panel ON sequences

- $0 < t_1 \leq 200 \text{ ms}$
- $t_2 \geq 0 \text{ ms}$
- $0 < t_3 \leq 200 \text{ ms}$
- $0 < t_4 \leq 40 \text{ s}$  (wait for assert in this range)
- $0 \leq t_5 \leq 250 \text{ ms}$
- $t_6 \geq 600 \text{ ms}$
- $t_7 \geq 1000 \text{ ms}$

## Panel OFF sequences

- $t_8 \geq 50 \text{ ms}$
- $t_9 \geq 0 \text{ ms}$
- $t_{10} \geq 0 \text{ ms}$
- $t_{11} \geq 0 \text{ ms}$
- $t_{12} \geq 0 \text{ ms}$

[Note] About the relation between data input and back light lighting, please base on the above-mentioned input sequence. When back light is switched on before panel operation or after a panel operation stop, it may not display normally. But this phenomenon is not based on change of an incoming signal, and does not give damage to a liquid crystal display.

In Panel ON sequence, please input black data (GS0) for LVDS when back light is not turned on.

## 6.4 Timing characteristics of input signals

Timing diagrams of input signal are shown in Fig.1.

| Parameter          |                          | Symbol | Min. | Typ   | Max. | Unit  | Remark  |
|--------------------|--------------------------|--------|------|-------|------|-------|---------|
| Clock              | Frequency                | 1/Tc   | -    | 145.8 | -    | MHz   | [NOTE1] |
| Data enable signal | Horizontal period        | TH     | -    | 1080  | -    | clock |         |
|                    |                          |        | -    | 14.8  | -    | μs    |         |
|                    | HSync                    |        | -    | 22    | -    | clock |         |
|                    | Horizontal back porch    |        | -    | 40    | -    | clock |         |
|                    | Horizontal period (High) | THd    | -    | 960   | -    | clock |         |
|                    | Horizontal front porch   |        | -    | 58    | -    | clock |         |
|                    | Vertical period          | TV     | 1117 | 1125  | 1133 | line  | [NOTE2] |
|                    |                          |        | -    | 60    | -    | Hz    |         |
|                    | VSynC                    |        | -    | 5     | -    | line  |         |
|                    | Vertical back porch      |        | -    | 10    | -    | line  |         |
|                    | Vertical period (High)   | TVd    | -    | 1080  | -    | line  |         |
|                    | Vertical front porch     |        | 22   | 30    | 38   | line  |         |

[Note]-When vertical period is out of range above, flicker and etc. may occur.

-When Horizontal period is different from above TH value, the screen may blackout.

-Please turn off the module after it shows the black screen.

-Please make sure that length of vertical period should become of an integral multiple of horizontal length of period. Otherwise, the screen may not display properly.

-As for your final setting of driving timing, we will conduct operation check test at our side, please inform your final setting.

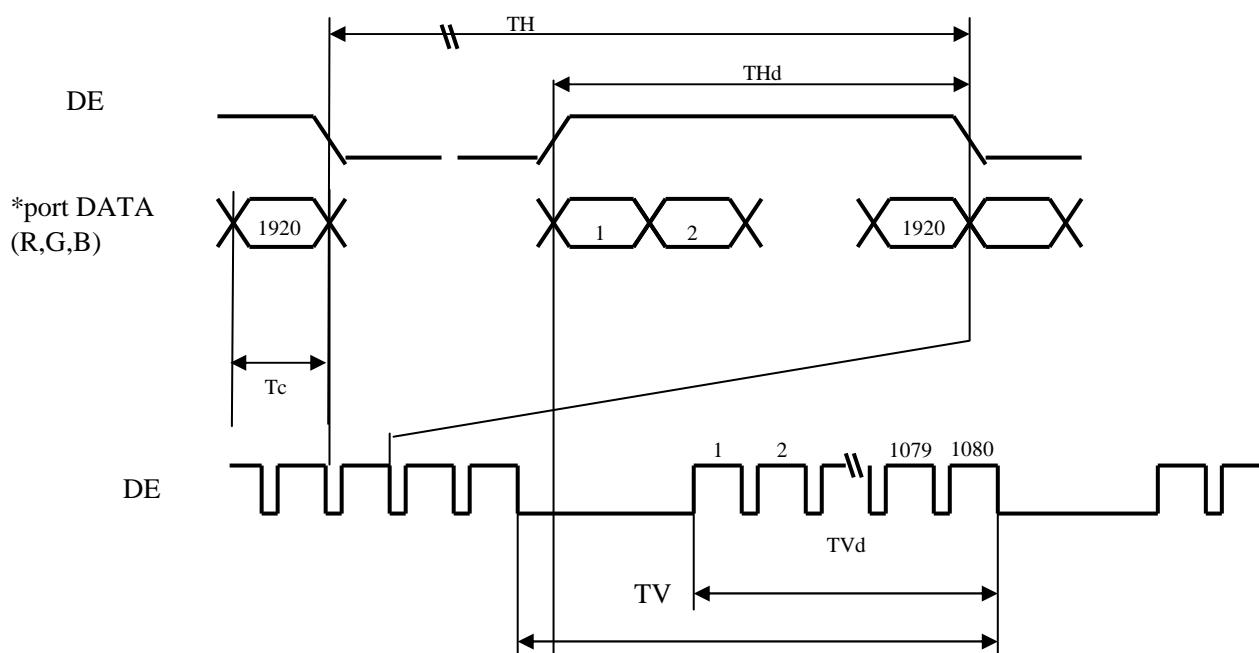
[NOTE1]

Limit of SS modulation (Spread Spectrum Modulation): Frequency: 30~60 kHz

: Modulation factor: Max. ±2%

[NOTE2]

Limit of secular change of vertical period: Max. ±1 line/frame



Timing characteristics of input signals

## 7. Optical characteristics

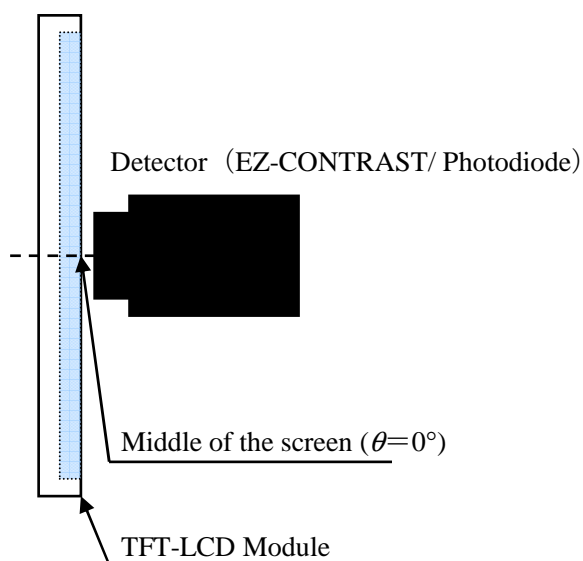
Ta=25°C, VCC=12.0V, LED ICC=45mA, LED PWM Burst= 99.97% , Timing :60Hz (typ.value)

| Parameter            |            | Symbol                     | Condition                 | Min.  | Typ.         | Max.  | Unit              | Remark    |
|----------------------|------------|----------------------------|---------------------------|-------|--------------|-------|-------------------|-----------|
| Contrast ratio       |            | CRn                        | $\theta=0^\circ$          | 3500  | 5000         | —     | —                 | [NOTE2,4] |
| Luminance of white   |            | x                          | $\theta=0^\circ$          | 0.250 | 0.280        | 0.310 | —                 | [NOTE4]   |
|                      |            | y                          |                           | 0.254 | 0.284        | 0.314 | —                 |           |
| Luminance of red     |            | x                          |                           | 0.612 | 0.642        | 0.672 | —                 |           |
|                      |            | y                          |                           | 0.320 | 0.350        | 0.380 | —                 |           |
| Luminance of green   |            | x                          |                           | 0.272 | 0.302        | 0.332 | —                 |           |
|                      |            | y                          |                           | 0.610 | 0.640        | 0.670 | —                 |           |
| Luminance of blue    |            | x                          |                           | 0.119 | 0.149        | 0.179 | —                 |           |
|                      |            | y                          |                           | 0.034 | 0.064        | 0.094 | —                 |           |
| Viewing angle range  | Horizontal | $\theta_{21}, \theta_{22}$ | $CR \geq 10$              | —     | 88           | —     | deg               | [NOTE1,4] |
|                      | Vertical   | $\theta_{11}, \theta_{12}$ |                           | —     | 88           | —     | deg               |           |
| Luminance            |            | $Y_L$                      | White<br>$\theta=0^\circ$ | —     | 2000         | —     | cd/m <sup>2</sup> | [NOTE4]   |
| Luminance uniformity |            | $\delta w$                 |                           | —     | 1.5<br>(TBD) | —     | —                 | [NOTE5]   |
| Response time        |            | $\tau$                     | $\theta=0^\circ$          | —     | 6            | —     | ms                | [NOTE3,4] |

Measurement condition: Set the LED PWM Burst to maximum

The measurement shall be executed 60 minutes after lighting at rating.

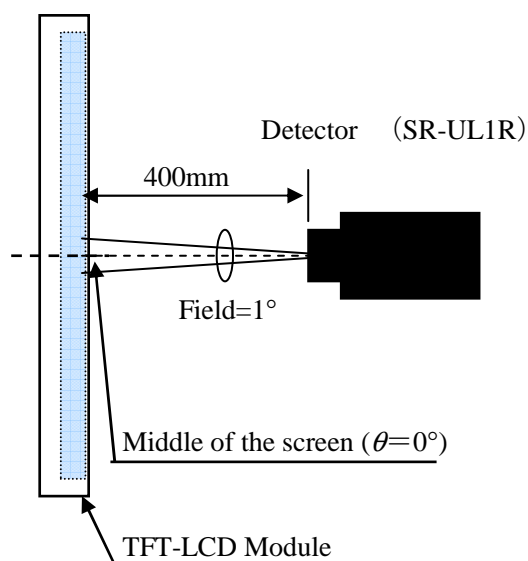
[Note]The optical characteristics are measured using the following equipment.



Measurement of viewing angle range and Response time.

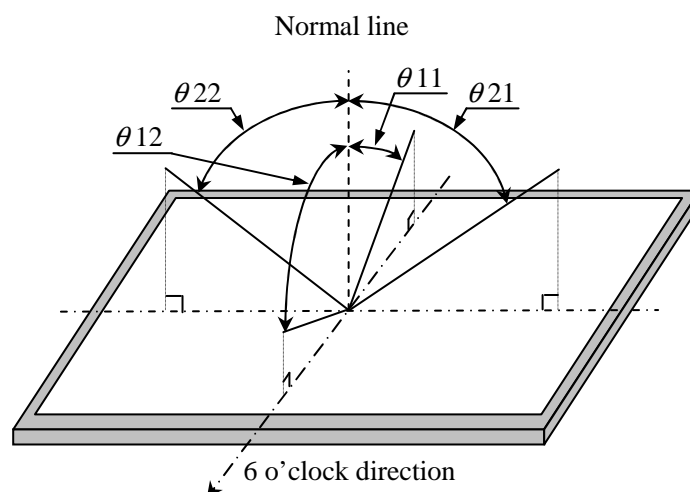
Viewing angle range: EZ-CONTRAST

Response time: Photodiode



Measurement of Contrast, Luminance, Chromaticity.

[Note 1]Definitions of viewing angle range :



[Note 2]Definition of contrast ratio :

The contrast ratio is defined as the following.

$$\text{Contrast Ratio} = \frac{\text{Luminance (brightness) with all pixels white}}{\text{Luminance (brightness) with all pixels black}}$$

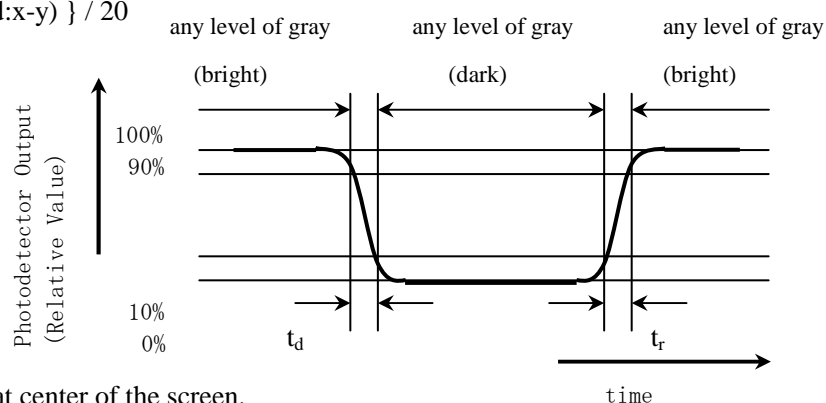
[Note 3]Definition of response time

The response time ( $T_{DRV}$ ) is defined as the following figure and shall be measured by switching the input signal for “any level of gray (0%, 25%, 50%, 75% and 100%)” and “any level of gray (0%, 25%, 50%, 75% and 100%)”.

|      | 0%          | 25%          | 50%          | 75%         | 100%         |
|------|-------------|--------------|--------------|-------------|--------------|
| 0%   |             | tr:0%-25%    | tr:0%-50%    | tr:0%-75%   | tr:0%-100%   |
| 25%  | td: 25%-0%  |              | tr: 25%-50%  | tr:25%-75%  | tr: 25%-100% |
| 50%  | td: 50%-0%  | td: 50%-25%  |              | tr: 50%-75% | tr: 50%-100% |
| 75%  | td: 75%-0%  | td: 75%-25%  | td: 75%-50%  |             | tr: 75%-100% |
| 100% | td: 100%-0% | td: 100%-25% | td: 100%-50% | td:100%-75% |              |

$t^*:x-y$ ...response time from level of gray(x) to level of gray(y)

$$\tau_{DRV} = \{ \Sigma (tr:x-y) + \Sigma (td:x-y) \} / 20$$

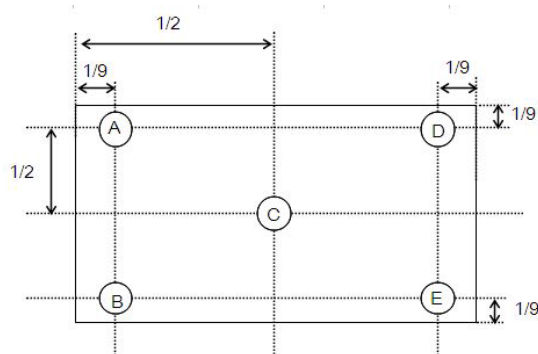


[Note 4]This shall be measured at center of the screen.

[Note 5] Definition of white uniformity ;

White uniformity is defined as the following with five measurements. (A~E)

$$\delta_w = \frac{\text{Maximum luminance of five points (brightness)}}{\text{Minimum luminance of five points (brightness)}}$$



## 8. Handling Precautions of the LCD module

- a) Be sure to turn off the power supply when inserting or disconnecting the cable.
- b) Be sure to design the cabinet so that the LCD module can be installed without any extra stress such as warp or twist.
- c) Since the front polarizer is easily damaged, pay attention not to scratch it.
- d) Since long contact with water may cause discoloration or spots, wipe off water drop immediately.
- e) When the panel surface is soiled, wipe it with absorbent cotton or other soft cloth.
- f) Since the panel is made of glass, it may break or crack if dropped or bumped on hard surface. Handle with care.
- g) Since CMOS LSI is used in this LCD module, take care of static electricity and take the human earth into consideration when handling.
- h) The LCD module has some printed circuit boards (PCBs) on the back side, take care to keep them from any stressor pressure when handling or installing the module; otherwise some of electronic parts on the PCBs may be damaged.
- i) Observe all other precautionary requirements in handling components.
- j) When some pressure is added onto the module from rear side constantly, it causes display non-uniformity issue, functional defect, etc.. So, please avoid such design.
- k) When giving a touch or hit the panel in supplying power, it may cause some kinds of degradation. In that case, once turn off the power supply, and turn on after several seconds again, and that is disappear.
- l) When handling LCD modules or assembling them into cabinets, please be noted that long-term storage in the environment of oxidization or deoxidization gas and the use of such materials as reagent, solvent, adhesive, resin, etc. which generate these gasses, may cause corrosion and discoloration of the LCD modules.
- m) Make sure that the LCD module is operated within specified temperature and humidity. Measures to avoid dust, water, vibration, and heat radiation, etc. are required with cabinet or other way. And image retention may occur if same fixed pattern is displayed for a long time. In some cases, it may not disappear.  
Please consider the design and operating environment
- n) Ultraviolet blocking filter is necessary in outdoor environment.
- o) Operation for 24 hours a day is NOT recommended.
- p) Image retention may occur if same fixed pattern is displayed for a long time.  
In some cases, it may not disappear. It is recommended to use moving picture periodically.  
After long-term static display, periodical power-off or screen saver is needed.  
For screen saver, moving picture or black pattern is strongly recommended.

## 9. Outline dimensions

| Tolerance   |      |       |
|-------------|------|-------|
| description |      |       |
| TO 25       | INCL | ±0.50 |
| OVER 25     | INCL | ±0.70 |
| TO 100      | INCL | ±1.00 |
| OVER 100    | INCL | ±1.50 |

Unit : mm

